# Sub-system integration and operation interface of the Linear IFMIF Prototype Accelerator (LIPAc)

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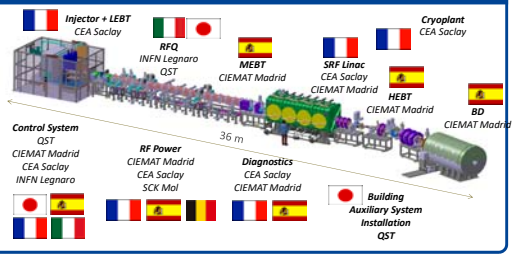
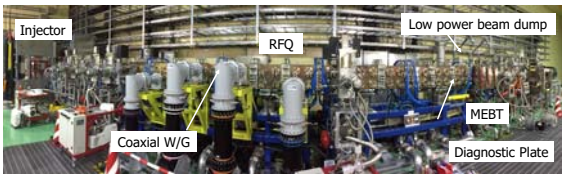
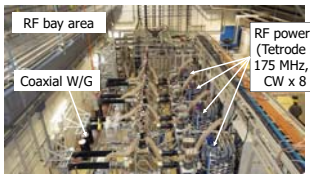
## Introduction

The installation and commissioning of **the Linear IFMIF Prototype Accelerator (LIPAc)** is progressing at Rokkasho Fusion Institute, QST (Japan). This prototype is aiming at accelerating a deuteron beam of 125 mA to 9 MeV in continuous wave mode (CW). Currently, the beam commissioning up to 5 MeV using short pulse, so-called 'Phase-B', is underway. In the Phase-B operation, we need to operate several sub-systems together delivered by different institutes, i.e. the injector from CEA (France), RFQ from INFN (Italy), MEBT and the RF system from CIEMAT (Spain) with utilities (cooling system, HVAC) supplied by QST. We started the beam commissioning in June 2018 after the successful integration and management of the interfacing of such a different subsystem into one accelerator system. The details of the integration of different subsystems and some improvements needed considering the feedback of this integration phase are presented.



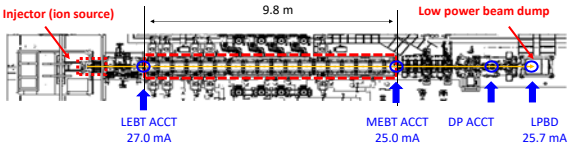

## LIPAc Phase-B configuration and result of the first campaign

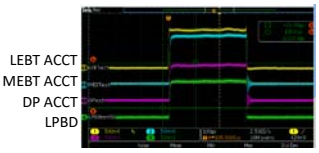


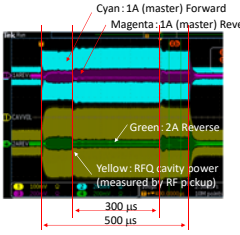




**1st proton beam was accelerated by LIPAc RFQ on 13 June 2018** with 300 μs pulse. (with the beam current of 1.7 mA at RFQ exit)

During a few weeks campaign, about 95% transmission of RFQ was confirmed with the beam current of 25 mA.



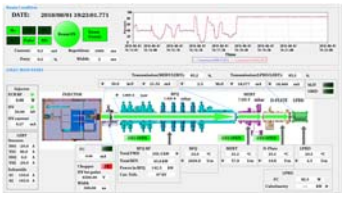

## Sub-system integration and operation interface

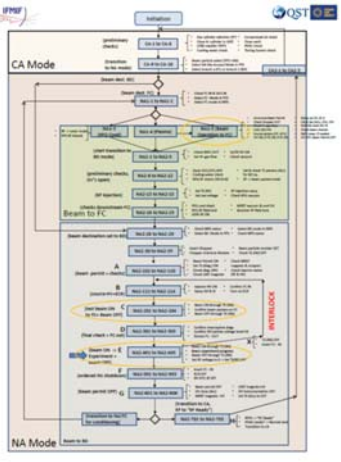
In LIPAc, most of the accelerator components were developed individually and delivered from Europe to Japan as in-kind contributions. QST is responsible for the installation, and the operation is done by a joint operation team Japan-Europe.

Each sub-system has its own local control system (LCS) and its interface, which was used in the individual check-out phase and the initial beam commissioning phase still.

The LCSs of each sub-system are integrated in the central control system (TS, MPS, PPS) developed by QST. The integration work was successfully done, but the 'integrated' operation interface is not yet ready. We had to use each LSC interface to operate, it was sometimes not very practical for operators or the beam turning purpose for which all subsystems need to work in collaboration with others, and we find there are some rooms for improvements. Many operator-wise interfaces have been created during the first commissioning campaign.

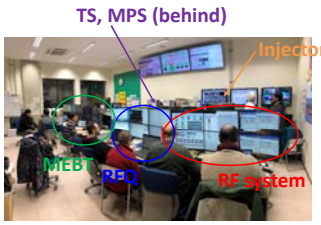
Some operation sequences can/should be automated in such an integrated operation interface, but instead of that, we constructed the operation flow chart for the day-1 and strictly followed it in order to ensure the safe operation of the machine.






LIPAc Phase B1 Operational Workflow

**Issue 1:**
**Each sub-system has own LSC arranged in different area. Not easy to communicate or closely cooperate.**




A new Central Control System? (to be continued)

**Issue 2:**
**Sometimes the user interface is too busy. Made for the true expert and not for operators.**

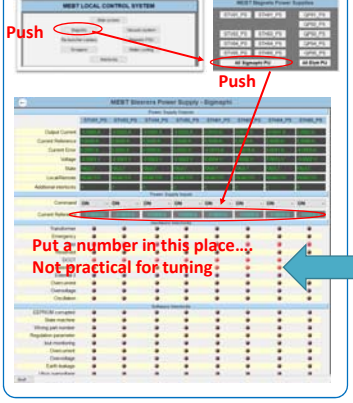
Example 1: LLRF operation panel

Impossible to understand at a glance

Example 2: Timing System operation window


**Issue 3:**
**Sometimes the user interface is not suitable for the beam tuning.**

Example: MEBT magnet operation panel




Good example (LEBT solenoids, steerers)

Practical for tuning

Simplified panel for operators

This work was undertaken under the Broader Approach Agreement between the European Atomic Energy Community and the Government of Japan. The views and opinions expressed herein do not necessarily state or reflect those of the Parties to this Agreement.